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Original research

INFLUENCE OF DIFFERENT CAVITY DISINFECTION SOLUTIONS AND LASER SYSTEMS ON REPAIR BOND STRENGTH OF SILORANE BASED COMPOSITE

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ABSTRACT

Purpose: To evalute the effects of Nd:YAG-laser, Er:YAG-laser, chlorhexidine and ozonated water application used for antibacterial effects on repair bond strength of silorane based composite.

Materials and Methods: 100 cavities (2 mm deep, 3 mm diameter) prepared in acrylic blocks were filled with silorane composite and subjected thermal cycle and divided into 5 groups (N=20). Group 1: Chlorhexidine; Group 2: Ozonated-water; Group 3: Nd:YAG-laser; Group 4: Er:YAG-laser; Group 5 (control): untreated. And disinfection method treated according to the groups. Composite repair procedure was implemented with the same silorane based composite. Groups divided into 2 subgroups (n=10). One of the subgroups for each group was subjected second thermal cycle. All of the samples tested by a universal test device. Data were statistically analyzed and significance test of the difference between the two means, the variance analysis, and Student-t Test used.

Results: No statistical difference was observed among groups after first thermal cycle ($p>0.05$). After the composite repair, there were no statistically significant difference between groups that were subjected to second thermal cycle ($p>0.05$). When each group was evaluated in themselves on comparing before and after the thermal cycle after the repair operation; as no statistically significant difference between Ozonated-water, Nd:YAG, Er:YAG and Control groups ($p>0.05$), a statistically significant decrease was observed only in the Chlorhexidine group after thermal cycle ($p<0.05$).

Conclusions: Ozonated-water, Nd:YAG-laser and Er:YAG-laser applications can be used in the repair of silorane-based composite restorations as an alternative antibacterial application, since the application of chlorhexidine reduces the repair bonding strength.

Key words: Er:YAG laser, composite repair, Chlorhexidine, Nd:YAG laser, ozonated water.

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INTRODUCTION

In recent years, composite resins have become the main preferred material for dental restorations. Continuous efforts are being made to improve the properties of these restorative materials. Composite restorative materials are traditionally based on methacrylate technology and these materials are constantly being developed to provide better physical properties and optimal aesthetic appearance.[1,2] In recent years new restorative materials such as silorane-based composite resins have been developed as alternatives to traditional composite resins.[3] These restorative materials have been produced to cope with polymerization shrinkage in polymeric composite resins during dental applications and polymerization stress afterwards.[4]

It is reported that secondary caries and marginal fractures are the main reasons for the failure of composite restorations.[5] Defective restorations are traditionally removed and the restoration is renewed. This operative approach leads to more loss of healthy tooth structure and requires a wider cavity preparation than before. For this reason, a minimally invasive approach has recently been proposed, which results in less material loss as a repair of the old restoration rather than the replacement of unsuccessful restorations, which increases the life of the original restoration.[6]

It is stated in the composite restorations that bonding between the two resin layers can be due to the non-polymerizable resin that inhibited by oxygen.[7] Since the unfinished restorations do not contain an unpolymerized layer on their surface, bonding with the new composite can occur with the compound effect of micromechanical retention and physico-chemical bonding.[8] Various in-vitro studies reveal that the composite-composite bond strength is adequate.[7-9]

Removal of small amounts of caries and discolorations at the tooth -restoration interface does not mean that all pathogenic bacteria are completely removed[10] and the continuity of the pathogenic bacteria may lead to repetition of the reprocessing caries which may lead to failure of the repair restoration.[11] Therefore, additional methods for disinfection of the repair area can be considered. Some preparations containing chlorhexidine are often recommended for cavity disinfection. However, studies have reported that chlorhexidine administration affects the binding strength of adhesive systems adversely.[12] Recently, the use of ozone treatment for cavity disinfection has been on the rise.[13,14]

Ozone has entered the practice of dentistry because of its antimicrobial effect against oral pathogens.[15] Gaseous ozone has been investigated for the treatment of occlusal caries[16] and root caries[17] while the liquid form has been proposed as an alternative for the treatment of periodontal disease due to its biocompatibility and anti-inflammatory potential.[18] Ozone gas and ozonated water are also used as cavity disinfection agents before bonding processes.[19,20]

Lasers in restorative dentistry used in cavity preparation, elimination of dentin sensitivity and preparation of the dentin surface prior to the application of adhesive systems.[21] Er:YAG laser[22,23] and Nd:YAG laser[24] which are frequently used in cavity and root canal disinfection due to their antibacterial effects on *streptococcus mutans (S. mutans)*, *lactobacilli*, *Enterococcus faecalis (E. faecalis)* in dentistry.

The purpose of this study is to investigate the effects of chlorhexidine, ozonated water, Nd:YAG laser and Er:YAG laser application using for antibacterial effects on the repair bond strength of silorane based composite restorative materials.

The null hypothesis of the study was that the all cavity disinfection methods would not effect the repair bond strength of silorane based composite.

MATERIALS AND METHODS

Ethics

Ethical approval was obtained from the Health Ethics Committee of Sivas Cumhuriyet University in Turkey (ID: 2013-11/02).

Sample Size Calculation and Experimental Groups

Sample size was calculated using a sample size calculator (Sample Size Determination in Health Studies, World Health Organization) as follows: power at 80%, α at 5%, β at 20%, and the sample

size was determined to be 20 teeth in each group. Thus, a total of 100 samples was prepared for the study.

Preparation of Experimental Specimens

In the preparation of the composite specimens, a metal block (15 mm diameter, 20 mm height) with cylindrical cavities (2 mm depth and 6 mm diameter) were prepared. A silicone mold were obtained from this metal block with silicone-based impression material (Bonasil, DMP Ltd., USA). The prepared silicon molds were filled with acrylic and waited until polymerize. Following the polymerization, the acrylic blocks were removed from the silicon mold. With this method, 100 acrylic blocks with a cavity of 2 mm in depth and 6 mm in diameter on one surface were obtained. A silorane-based composite (Filtek Silorane, 3M Espe, St Paul, MN, USA) was placed in a single layer to the cavities. After placement of the composite resin in the cavities, polymerization was carried out using a LED light device (Valo Cordless, Ultradent Products Inc, SJ, Utah) with a power output of 1400 mW/cm² and a distance of 1 mm for 20 seconds in accordance with the manufacturer's instructions. In this way 100 composite samples were obtained.

Artificial aging of specimens

All the samples prepared were aged for 5,000 cycles in the thermal cycling to simulate oral environment conditions. The thermal cycling was carried out in 5°C and 55°C (±2°C) temperature baths, with a transfer time of 5 seconds and a dwell time of 30 seconds respectively.

Samples group design

After aging procedures, composite surfaces were ground with 400 μm grit silicon carbide paper to obtain a homogeneous surface. And then all specimens were divided into 5 groups with 20 composite samples in each group (N=20).

Group 1: Each sample surface treated 2% chlorhexidine with a disposable brush for 30 s and gently dried with air sprey. Afterwards, the self-acidic primer of the Silorane Adhesive System (Filtek Silorane Primer, 3M Espe, St Paul, MN, USA) was applied to the surface of the composite samples with a disposable brush for 15 seconds. It was slightly air-dried and polymerized for 10 s with an LED light device (Valo Cordless, Ultradent Products Inc, SJ, Utah) at a distance of 1 mm. Then the adhesive of the system in the second bottle (Filtek Silorane Bond, 3M Espe, St Paul, MN, USA) was applied with a different disposable brush and slightly thinned with air spray. The polymerization of the bonding agent was achieved for 10 s with the LED light device. The intensity of the light source was measured with a radiometer at every 5 samples, and the light intensity level was tried to be kept constant in all samples.

Following the adhesive application, a cylindrical transparent pipe with a diameter of 3mm and a height of 2 mm prepared previously was placed in the restoration center as a matrix to the repair composite material. Silorane-based composite (Filtek Silorane, 3M Espe, St Paul, MN, USA) was placed inside this transparent pipe with the help of hand instrument and polymerized from a distance of 1 mm for 20 s. Following polymerization, the transparent matrix was carefully cut away with a lancet.

Group 2: Ozonated water was used as a disinfectant in the samples in this group. Ozonated water were obtained using ozone producing generator (tekno3zo to, Izmir, Turkey). With the help of the ozone measurement probe in the reactor tank where distilled water is placed, the ozone density is displayed on the digital display on the device.

Ozonated water at a concentration of 4 ppm (mg/lt) was applied to the exposed surfaces of each of the 20 composite samples in the group with a disposable brush for 15 s and dried slightly with air spray and silorane adhesive system (Prmer-Bond) was applied and the repair process was carried out in Group 1. It was carried out with a silorane-based composite (Filtek Silorane, 3M Espe) as described above.

Group 3: The parameters of the Nd:YAG laser device were set to pulse at a wavelength of 1.064 nm, a power of 1.5W, an energy level of 100 mJ, and a frequency of 15 Hz. It was applied with a fiber optic tip with a diameter of 300 μm from a distance of 1 mm from the composite surface, so that the entire surface was treated. The repair procedure was carried out as in the previous

groups using a silorane adhesive system and a silorane-based composite (Filtek Silorane, 3M Espe).

Group 4: Er: YAG Laser was used as a disinfectant in this group. Er: YAG laser was applied at a wavelength of 2940 nm, 1.5W power, 150 mJ energy level, 10 Hz frequency, 700 ms long pulse to scan the entire composite surface from a distance of 10 mm (Figure 3.13). Repair process was carried out using silorane adhesive system and silorane based composite (Filtek Silorane, 3M Espe) as in the other groups.

Group 5 (Control group): 20 composite samples were repaired with a silorane adhesive system and a silorane-based composite (Filtek Silorane, 3M Espe) without any disinfection method.

Second aging procedure

Each group was divided into two subgroups (n=10). In order to evaluate the long-term performance of the restorations, a subgroup of each group was re-stored in the thermal cycle device for 5000 cycles. Thermal cycle application was carried out in a temperature of 5°C and 55°C (±2°C), respectively, with a transfer time of 5 s and a waiting time of 30 s. Thus, it was ensured that the composite restorations were exposed to the temperature changes in the oral environment after the repair. (Figure 1)

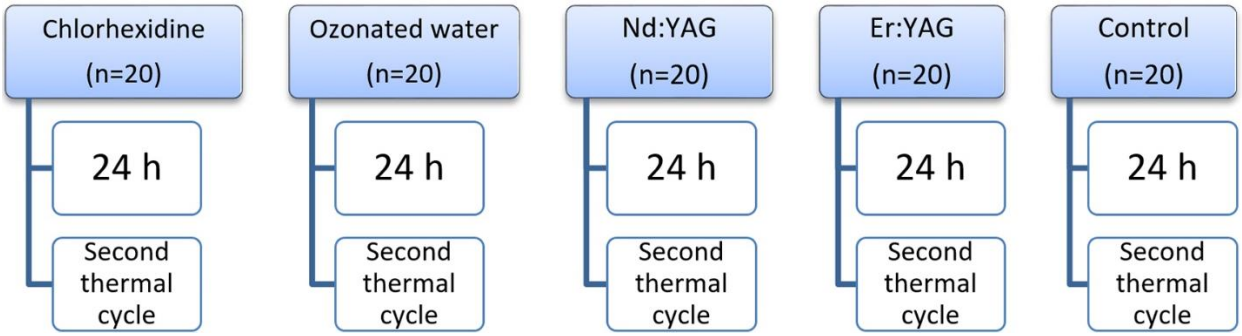

Figure 1. Schematic view of group design

Half of the samples (n_1=10) in the groups were subjected to the shear bond strength test immediately after being kept in distilled water at 37ºC for 24 hours. The other half of the samples (n_1=10) were subjected to shear bond strength test after a second aging in thermal cycle.

Shear Bond Strength Test

The shear bond strength test was carried out using a Universal Testing machine (LF Plus, LLOYD Instruments, Ametek Inc. England). The shear aparatus utilized 90º load application angle to the repair composite with a 1 mm/min crosshead speed and load cell of 1 kN until fracture occured and shear bond strengths were calculated in MPa.

After shear bond strength test, the fracture surfaces of all specimens were examined under a self-luminous stereomicroscope (SMZ 800, Nikon, Tokyo, Japan) at 32X magnification and the types of failures were categorized as A) adhesive at the interface, B) cohesive in the substrate, C) cohesive in the repair composite, D) mix type (adhesive + cohesive in the repair composite)

Statistical analysis

Statistical analysis was performed using SPSS (ver: 22.0) software. When the parametric assumptions were fulfilled (Kolmogorov-Simirnov) variance analysis was used to investigate whether there was a difference between experimental groups before thermal cycling and after thermal cycling shear bond strength values. While investigating whether there is a difference between the shear bond strength values before and after the second thermal cycle in each group, the significance test (Student t) of the difference between the two means in independent groups was used and the level of error was taken as 0.05.

RESULTS

As a result of the statistical analyses, no statistically significant difference was observed between all groups in terms of shear bond strength in the evaluation after the first thermal cycle application (p>0.05). Table 1 shows the mean values and standard deviations of the repair shear bond strength test of the control and experimental groups.

Table 1. Statistical comparison of the mean repair shear bond strength values before and after the second thermal cycle in the groups

Groups	24 h		Second thermal cycle		*P value*
	Mean(MPa)	SD	Mean(MPa)	SD	
Chlorhexidine	16.86	± 2.39^{a,A}	12.82	± 3.21^{b,A}	t=3.18 P=0.005 *
Ozonated water	16.37	± 2.84^{a,A}	13.99	± 3.39^{a,A}	t=1.69 P=0.107
Nd:YAG	17.57	± 2.38^{a,A}	15.15	± 3.65^{a,A}	t=1.75 P=0.096
Er:YAG	17.41	± 2.43^{a,A}	15.83	± 2.85^{a,A}	t=1.33 P=0.199
Control	16.96	± 4.09^{a,A}	16.12	± 3.68^{a,A}	t=0.48 P=0.635
	F=0.28 *p*=0.885		F=1.69 *p*=0.180		

*(p<0.05); ** In each row, groups with the same lower case letter superscripts are not significantly different, and in each column, groups with the same upper case letter superscripts are not significantly different

A statistically significant difference was not observed in terms of repair shear bonding strength values between all groups that were subjected to the second thermal cycle after the composite repair procedure was applied (p>0.05) (Table 1).

When each group was evaluated within itself in the comparison before and after the second thermal cycle after repairing all samples; A statistically significant decrease was observed in the repair shear bond strength values after thermal cycle application in the chlorhexidine group. (p<0.05) (Table 1).

Failure types results

When the failure types of the experimental samples were examined under the stereomicroscope, adhesive failure, cohesive failure at the restoration material, cohesive failure at the repair material and mixed failure types were determined. The predominant type of failure in all groups was found to be mixed type failure. The distribution of failure types is shown in Figure 2 and SEM images of failure types of groups shown in Figure 3.

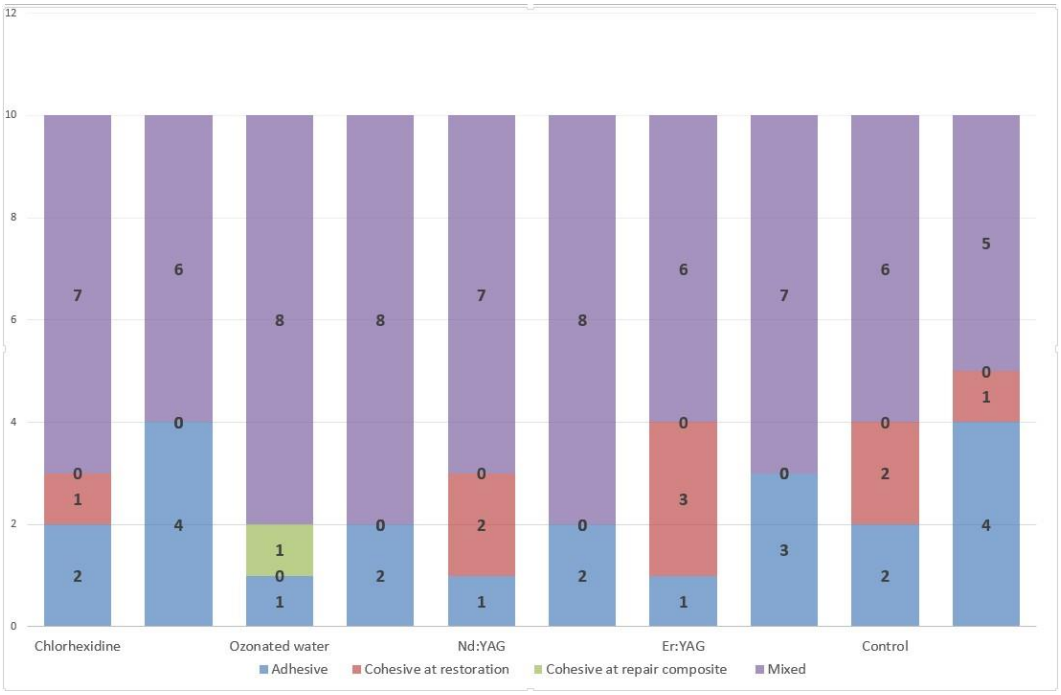

Figure 2. Distribution of failure types

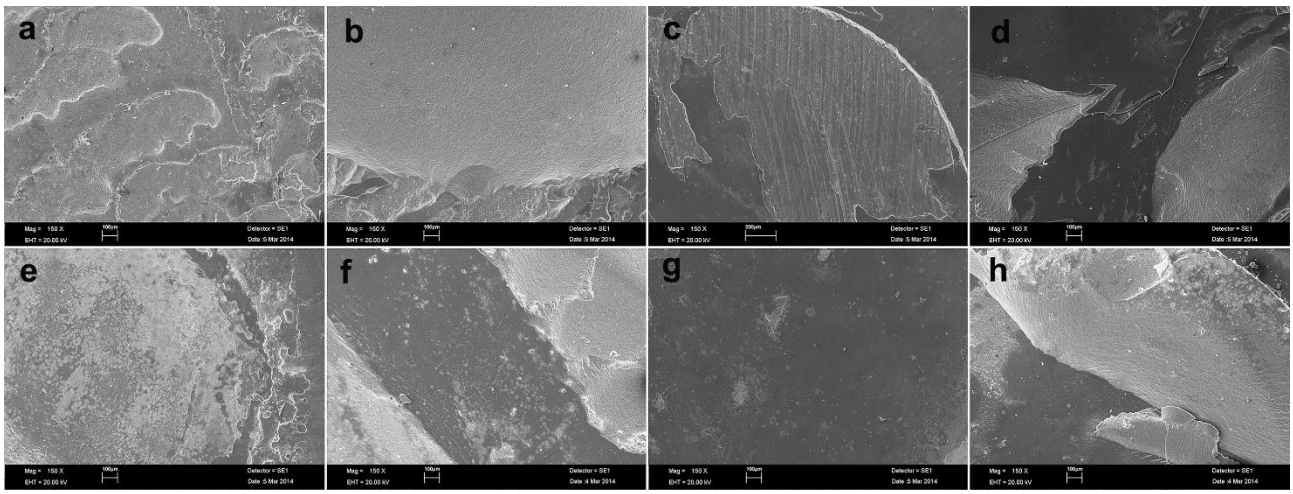

Figure 3. SEM images of failure types, **a:** Adhesive type failure belongs to Er:YAG laser group, **b:** Cohesive type failure belongs to ErYAG laser group, **c:** Adhesive type failure belongs to chlorhexidine group, **d:** Mixed type failure belongs to chlorhexidine group, **e:** Adhesive type failure belongs to Nd:YAG laser, **f:** Mixed type failure belongs to Nd:YAG laser, **g:** Adhesive type failure belongs to ozonated water group, **h:** Mixed type failure belongs to ozonated water group

DISCUSSION

The repair of a failed restoration rather than replacement is a good alternative to avoid the unnecessary loss of tooth structure. When secondary caries and discolored restoration margins are removed prior to repair, the possibility of there being cariogenic bacteria in the repair site becomes a concern. In addition to lesion removal, the disinfection of the cavity has been recommended to eliminate the risk for caries recurrence due to the presence of residual bacteria under the restoration.[11,25] The feature desired in a cavity disinfectant, besides its antimicrobial activity, is the lack of any detrimental effect on adhesive processes during the restoration repair. According to previous studies, chlorhexidine is one of the most effective chemotherapeutic agent against mutans streptococci and dentin caries, and is widely used.[26] Common disinfectants, such as chlorhexidine or sodium hypochlorite, have also been reported to have a negative effect on adhesion[27], leading to research into new products.[25] There are encouraging previous studies regarding the use of ozone application in dental hard tissues prior to adhesive procedures.[20]

In the present study the null hypothesis was accepted. All cavity disfection methods used in the study did not affect repair bond strength of silorane based composite. Chlorhexidine group did not show any statistically significant difference in repair shear bond strength values, both before and after thermal cycling, compared to other groups (Table 1). The findings of this study are consistent with those of previous studies using etch-and-rinse and two-step self-etch adhesive systems.[28-30] In such studies, the authors suggested that the lack of any negative effect of chlorhexidine application on the bond strength of adhesive systems was due to the compatibility of the adhesive resin used with chlorhexidine. It has been reported that the effect of disinfectant agents, such as chlorhexidine, on the bonding of composite restorations depends on the type of adhesive resin and the interaction of the adhesive resin with disinfectant agents.[31]

The present study examined the effect of 4 ppm ozonated water application on the repair strength of the silorane-based restorative material and the ozonated water group did not show any statistically significant difference in the repair shear bond strength values, both before and after thermal cycling, compared to other groups (Table 1). The findings of this study are consistent with those of bond strength studies using ozonated water application in dental hard tissues.[19,32,33]

Pithon and Santos.[32] have demonstrated that ozonated water did not have a negative effect on the bond strength of resin-modified glass ionomer cements. Ozonated water, when compared with other disinfectant agents such as sodium hypochlorite (2.25%), chlorhexidine (2%) and gaseous ozone, did not show any statistical difference.[34] Garcia *et al.*[19] examined the effect of gaseous ozone and ozonated water on the composite resin-dentin bond strength of two-step adhesive systems (Adper Single Bond 2, XP

Bond), and reported that ozone water does not have a negative effect on the bond strength.

Papacchini *et al.*[35] have shown that hydrogen peroxide has a detrimental effect on composite repair bond strength, especially when an adhesive is used as an intermediate bonding agent. The authors suggested that this result was due to the undesired interaction of residual hydrogen peroxide and oxygen on the composite surface to be repaired, and reported that oxygen, which could diminish the polymerization of the intermediate bonding agent used in the repair, originated from the atmosphere [35]. It could be argued that the oxidative effect of ozone does not lead to the formation of critical amounts of oxygen by-products on the composite surface. The fact that the ozone, applied directly or following thermal cycling has no effect on the micromechanical properties of the composite (Table 1), supports the hypothesis that chemical modification of the composite surface by ozone application is unlikely [36]. On the other hand, there are reports of commonly used bleaching agents such as hydrogen or carbamide peroxide affecting certain physical properties of the composite.[37-39]

Ozone application to resin-dentin interfaces can be compared with applications of other oxidants such as hydrogen peroxide used for bleaching and sodium hypochlorite used for storage.[40-43] For instance, these two products cause deterioration in the adhesive interface;[40-42] however, the present study, as shown in Table 1, observed no difference between ozone-treated groups and the control group. This may be due to the low concentration of ozone and the short contact time.[19]

There are several studies showing that the Nd:YAG laser causes changes and modifications on enamel and dentin surfaces.[44,45] Oskoee *et al.*[46] examined the effect of Nd:YAG (3W, 150 mJ, 20 Hz) laser on the repair bond strength of a silorane-based composite and reported that the Nd: YAG laser significantly increases the repair bond strength compared to the control group. Türkmen *et al.*[47] reported that the Nd:YAG laser application to the composite resin surface results in crater formations, microcracks and porosities on the composite surface. We consider that the increased bond strength in these studies[46-48] may be due to the microretention caused by the use of Nd:YAG laser in high modes.

In the present study repair SBS were not affected by the Nd:YAG laser application (Table 1). Compared to ozonated water and chlorhexidine groups, there was no statistically difference in bond strength, although the bond strength values were slightly higher in the Nd: YAG group ($p>0.05$).

The Er:YAG laser causes ablation on the composite surface through explosive vaporization and subsequent hydrodynamic ejection. During this process, the rapid softening and consequent change in the volume of molten materials create strong suspension masses. The interaction between the masses and the composite resin structure creates protrusions on the surface and the molten materials are removed from the surface in droplets. This microretentive morphology formed on the composite resin surface increases the surface area.[49] The increased surface area results in an increase in the bonding surface area and modifies the stress distribution at the interface of the two bonded materials.[50] All these events lead to an increase in the repair bond strength.

In present study Er: YAG laser was used (power, 1.5W; energy level, 150 mJ; frequency, 10 Hz) as a cavity disinfectant due to its bactericidal effect.[51] In the present study repair SBS values were not affected by the Er:YAG laser application ($p>0.05$) (Table 1). Compared to ozonated water and chlorhexidine groups, there was no statistically significant difference in bond strength, although the bond strength values were slightly higher in the Er:YAG group. Findings of this study are similar to those of previous studies that evaluated the composite repair bond strength using the Er:YAG laser.[52,53]

The variation in the studies' findings may be related to the type of composite used because the content of the composite resin could affect the efficacy of mechanical surface treatments.[54] While various components of the resin-based parts of the composites absorb the laser energy, the filler particles of dental composites scatter the laser energy.[55] Lizarelli *et al.* investigated the ablation rate and morphological impact of the Er:YAG

laser on different types of composite resin such as microfiller, hybrid, and condensable, and reported that micromorphological aspects, penetration rate and ablation rate were dependent on the structure and chemical composition of composite resin as well as laser parameters.

In the present study predominant fracture type in all groups was determined as mixed-type fracture (Figure 2). When silorane composites are used with a compatible adhesive during repair, a more stable interface is obtained, which positively affects bonding . However, the dentist may not always be able to identify the original restoration and select the correct repair composite and the correct adhesive.[56]

The repair of composite restorations is usually required months or years after their insertion. During aging, various changes occur in composites, such as water absorption, chemical degradation, and leakage of some components, all of which affect the success of the repair procedure.[50] Thus, the age of the repaired restoration plays a fundamental role in the bond strength of composite repairs.[57]

Thermal cycling is frequently used in laboratory settings to mimic the stress caused by temperature changes at the interface between materials with different thermal expansion coefficients due to environmental conditions. Papacchini *et al.*[9] examined the hydrolytic stability of different composite repair procedures by subjecting them to thermal cycling and found a significant decrease in composite-composite repair strength after thermal cycling only in the group in which an etch-and-rinse adhesive system was applied together with a non-prehydrolyzed silane as an intermediate bonding agent. The present study, when each group was evaluated within itself in the comparison before and after thermal cycling, found no statistically significant difference in the repair shear bond strength values between ozonated water, Nd:YAG, Er:YAG and the control groups (Table 1). This demonstrated that the adhesive intermediate bonding layer also formed a stable bonding in the repair of the new restorative material.[36]

The data of this study are in agreement with those of previous studies.[9,36,56,58] However, it has also been reported that the composite bond strength decreases after performing a higher number of thermal cycles.[59] Present study established a statistically significant decrease in the repair shear bond strength values after thermal cycling only in the chlorhexidine group (Table 1).

Due to the scarcity of findings in the literature on this subject, it was not possible to compare the findings of the present study, which was planned to reveal the effect of chlorhexidine and ozonated water applications for cavity disinfection purposes on the repair shear bond strength values when used with the compatible adhesive of silorane-based composites. However, we believe that this study will be a step for further studies on this matter.

CONCLUSIONS

Applications of ozonated water, Nd:YAG laser and Er:YAG laser did not affect the repair bond strength of the tested silorane-based composite when compatible adhesive was used. However, the bond strength values were found to be higher in the laser groups. It was established that the application of chlorhexidine significantly reduced the repair bond strength of the silorane-based composite after thermal cycling, while the repair bond strength of the ozonated water, Nd:YAG laser and Er:YAG laser groups was not affected by thermal cycling. Since the chlorhexidine application reduced the repair bond strength of silorane-based composites after aging procedure, it is believed that ozonated water, Nd:YAG laser and Er:YAG laser can be used as disinfectants in the repair of silorane-based composite restorations as an alternative antibacterial treatment following the removal of secondary caries in the margins of failed composite restorations.

Farklı Antimikrobiyal Solüsyonların ve Lazer Sistemlerinin Siloran Bazlı Kompozitlerin Tamir Dayanımı Üzerine Etkisi

ÖZ

Amaç: *Antibakteriyel etkileri sebebiyle kullanılan ozonlu su, klorheksidin, Er:YAG lazer ve Nd:YAG lazer uygulamalarının yaşlandırma öncesi ve sonrası siloran bazlı kompozit restoratif materyallerinin tamir dayanımı üzerine incelenmesi* ***Gereç ve yöntem:*** *Akrilik bloklar üzerine 2 mm derinlik ve 3 mm çapında 100*

kavite hazırlandı ve siloran bazlı kompozit ile doldurularak polimerize edildi. Tüm örnekler tamir işlemi öncesi yaşlandırma işlemine tabi tutuldu ve sonrasında 5 gruba ayrıldı (N=20). Grup 1: Klorheksidin; Grup 2: Ozonlu su; Grup 3: Nd:YAG-lazer; Grup 4: Er:YAG-lazer; Grup 5 (kontrol): İşlem uygulanmayan. Dezenfeksiyon işlemi gruplar doğrultusunda yapılarak siloran bazlı bir kompozitle tamir işlemi gerçekleştirildi. Sonrasında gruplar iki altgruba ayrılarak (n=10) bir alt gruba termal yaşlandırma işlemi uygulandı. Bütün örnekler üniversal test cihazında bağlanma dayanımı testine tabi tutuldu. Elde edilen verilerin istatistiksel analizi varyans analizi ve Student-t testi ile gerçekleştirildi. ***Bulgular:*** *Yaşlandırma öncesi gruplar arasında istatistiksel olarak fark bulunmamıştır. (p>0,05). Yaşlandırma sonrası da gruplar arası istatistiksel bir fark görülmezken (p>0,05) gruplar yaşlandırma öncesi ve sonrası kendi içerisinde karşılaştırıldığında ozonlu su, Nd:YAG laze, Er:YAG lazer ve kontrol gruplarında istatistiksel olarak anlamlı bir fark bulunmazken (p>0,05), klorhekzidin grubunda yaşlandırma sonrası tamir bağlanma kuvveti anlamlı bir şekilde azalmıştır (p<0,05).* ***Sonuç****: Ozonlu su, Nd:YAG-lazer ve Er:YAG-lazer uygulamaları siloran bazlı kompozitlerin tamirinde alternatif dezenfektan olarak uygulanabilir. Ancak klorheksidin uygulaması yaşlanma sonrası tamir bağlanma kuvvetini azaltmaktadır.* ***Anahtar kelimeler:*** *Er:YAG lazer, kompozit tamiri, klorhekzidin, Nd:YAG lazer, ozonlu su.*

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